Space Webs as Infrastructure For Crawling Sensors on Low Gravity Bodies

Juliana Cherston[1], Joseph A. Paradiso[2]
Responsive Environments Group, MIT Media Lab
[1] cherston@media.mit.edu [2]joep@media.mit.edu

Mission Concept

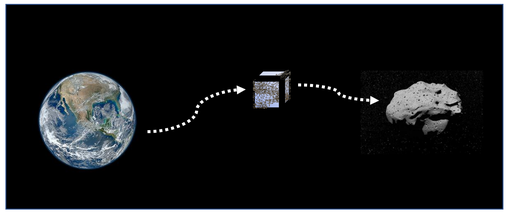
The technology to land *many* rovers on low gravity bodies will be necessary for in-situ distributed sensing

Problem: difficult to land and to move on low-gravity bodies. Single-point-of-contact anchors susceptible to failure

Solution: Use net or rope to grapple onto body; net doubles as infrastructure to enable locomotion of crawler swarm

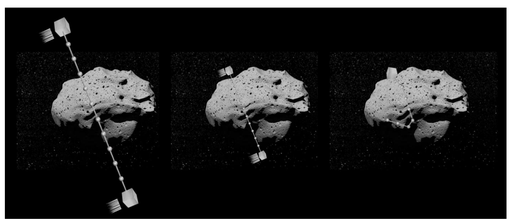
1

Kilometer-scale, sensor-equipped net or rope is tightly packaged into small satellite



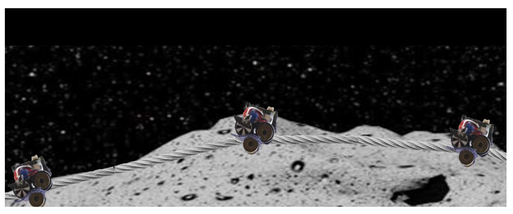
2

Upon arrival, net or rope is launched at body of interest, adhering to the body's surface



3

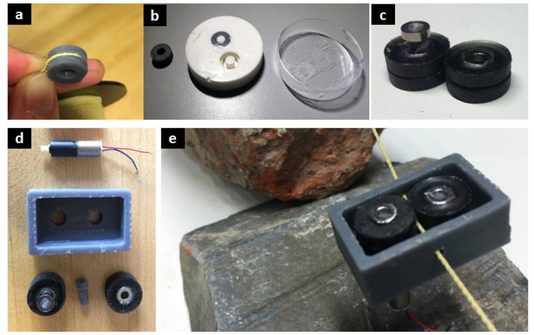
Crawling sensors work in collaboration to take high spatial resolution, in-situ measurements



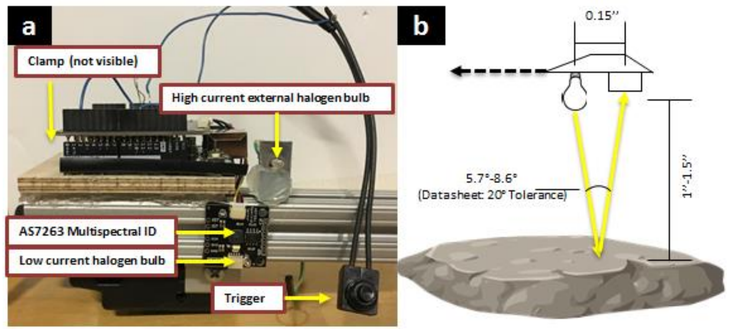
Example Applications

- Distributed spectroscopy
- Distributed seismology (using impactor)
- Distributed X-ray or alpha tomography
- Rigidization + passive control for distributed aperture imager or phased array antenna
- Terrain mapping

Initial Prototyping



Crawling mechanism prototype: rubber casted magnetic pinch roller crawling on Kevlar rope

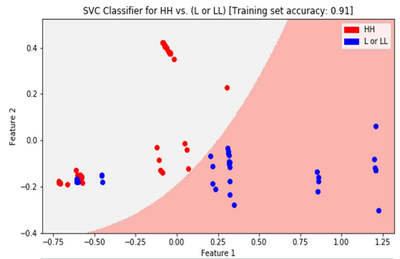


Evaluation of AS7263 - a new-to-market chip-sized multispectral sensor ($8, 4mm^2) - for discrimination between high iron and low iron meteorite samples

Next Steps: Validation + Adherence Mechanism Prototyping

Validate Initial Spectral Sensor Findings:

- 91% discrimination between high iron and low iron samples for training data using principal component analysis (left; pending further sensor calibration)
- Consider alternative sensing payloads

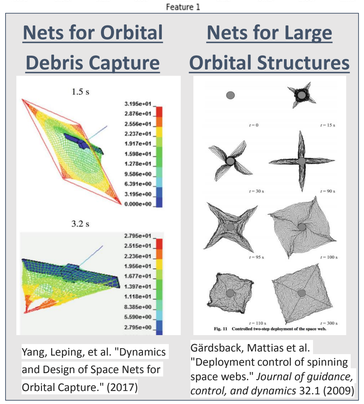


Adhesion + Rigidization Methods to be Considered:

- Extrusion of a fast-setting adhesive upon contact
- Contact melting to freeze the net in place
- Penetrating micro-anchors
- Bi-stable snapping onto the body upon contact

Net Dynamics in Microgravity:

- Draw from prior space web modeling efforts (right)
- Also study integration of power/com lines into net



Yang, Leping, et al. "Dynamics and Design of Space Nets for Orbital Capture." (2017)

Gärdsback, Mattias et al. "Deployment control of spinning space webs." *Journal of guidance, control, and dynamics* 32.1 (2009)